

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

To:

FORSSÉN & SALOMAA OY
Yrjönkatu 30
FIN-00100 Helsinki
FINLANDE

Date of mailing (day/month/year) 30 March 2001 (30.03.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference HJ/FI991096	
International application No. PCT/FI00/00419	International filing date (day/month/year) 10 May 2000 (10.05.00)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address VALMET CORPORATION Fabianinkatu 9 A FIN-00130 Helsinki Finland	State of Nationality FI	State of Residence FI
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address METSO PAPER, INC. Fabianinkatu 9 A FIN-00130 Helsinki Finland	State of Nationality FI	State of Residence FI
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer C. Cupello Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference HJ/FI991096	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/FI00/00419	International filing date (<i>day/month/year</i>) 10.05.2000	Priority date (<i>day/month/year</i>) 12.05.1999
International Patent Classification (IPC) or national classification and IPC ₇ D 21 F 11/00, D 21 F 9/00		
Applicant METSO PAPER INC. et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 17.10.2000	Date of completion of this report 06.08.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Mattias Arvidsson/ELY Telephone No. 08-782 25 00

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00419

I. Basis of the report**1. With regard to the elements of the international application:***

- ☒ the international application as originally filed
- ☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.These elements were available or furnished to this Authority in the following language English which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☒ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00419

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	<u>1-30</u>	YES
	Claims	_____	NO
Inventive step (IS)	Claims	<u>1-30</u>	YES
	Claims	_____	NO
Industrial applicability (IA)	Claims	<u>1-30</u>	YES
	Claims	_____	NO

2. Citations and explanations (Rule 70.7)

The documents cited in The International Search Report represent the prior art. The claimed invention, as stated in claims 1-30, is not considered to be anticipated by these documents. None of the documents or any relevant combination of them reveal a method for the manufacture of paper, or a paper machine line for the manufacture of paper, as described by these claims.

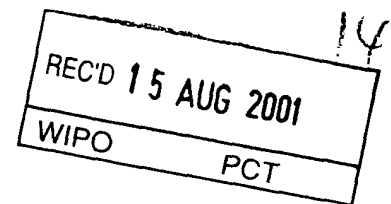
Thus, the invention according to claims 1-30 is novel, considered to involve an inventive step, and have industrial applicability.

PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)



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Applicant METSO PAPER INC. et al		

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Date of submission of the demand 17.10.2000	Date of completion of this report 06.08.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Mattias Arvidsson/ELY Telephone No. 08-782 25 00

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International application No.

PCT/FI00/00419

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- ☐ the description:
pages _____, as originally filed
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- ☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
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- ☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
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International application No.

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	Claims		NO
Inventive step (IS)	Claims	<u>1-30</u>	YES
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Industrial applicability (IA)	Claims	<u>1-30</u>	YES
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2. Citations and explanations (Rule 70.7)

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Thus, the invention according to claims 1-30 is novel, considered to involve an inventive step, and have industrial applicability.

RECORD COPY

PCT REQUEST

1/4

HJ/FI991096

Original (for **SUBMISSION**) - printed on 10.05.2000 11:24:49 AM

0 0-1	For receiving Office use only International Application No.	PCT/FI 0 0 / 0 0 4 1 9
0-2	International Filing Date	1 0 MAY 2000 (1 0 -05- 2000)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4 0-4-1	Form - PCT/RO/101 PCT Request Prepared using	PCT-EASY Version 2.90 (updated 08.03.2000)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	HJ/FI991096
I	Title of invention	METHOD FOR MANUFACTURE OF PAPER, IN PARTICULAR OF FINE PAPER, AND A PAPER MACHINE LINE IN PARTICULAR FOR MANUFACTURE OF FINE PAPER
II II-1 II-2 II-4 II-5	Applicant This person is: Applicant for Name Address:	applicant only all designated States except US VALMET CORPORATION Fabianinkatu 9 A FIN-00130 HELSINKI Finland
II-6 II-7	State of nationality State of residence	FI FI
III-1 III-1-1 III-1-2 III-1-4 III-1-5	Applicant and/or inventor This person is: Applicant for Name (LAST, First) Address:	applicant and inventor US only RAUTIAINEN, Pentti Kauhavankuja 4 FIN-04430 JÄRVENPÄÄ Finland
III-1-6 III-1-7	State of nationality State of residence	FI FI

PCT REQUEST

HJ/FI991096

Original (for SUBMISSION) - printed on 10.05.2000 11:24:49 AM

IV-1	Agent or comm n r representative; or address f r correspondence The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	FORSSÉN & SALOMAA OY
IV-1-2	Address:	Yrjönkatu 30 FIN-00100 HELSINKI Finland
IV-1-3	Telephone No.	+358 9 615 3500
IV-1-4	Facsimile No.	+358 9 615 35111
IV-1-5	e-mail	forsapat@fspat.fi
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT (patent and utility model) AU AZ BA BB BG BR BY CA CH&LI CN CR CU CZ (patent and utility model) DE (patent and utility model) DK (patent and utility model) DM DZ EE (patent and utility model) ES FI (patent and utility model) GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK (patent and utility model) SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW

PCT REQUEST

HJ/FI991096

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V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) from precautionary designations	NONE
VI-1	Priority claim of earlier national application	
VI-1-1	Filing date	12 May 1999 (12.05.1999)
VI-1-2	Number	991096
VI-1-3	Country	FI
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)
VIII	Check list	number of sheets electronic file(s) attached
VIII-1	Request	4 -
VIII-2	Description	13 -
VIII-3	Claims	5 -
VIII-4	Abstract	1 991096.txt
VIII-5	Drawings	1 -
VIII-7	TOTAL	24
VIII-8	Accompanying items	paper document(s) attached electronic file(s) attached
VIII-8	Fee calculation sheet	✓ -
VIII-9	Separate signed power of attorney	✓ -
VIII-10	Copy of general power of attorney	✓ -
VIII-16	PCT-EASY diskette	- diskette
VIII-17	Other (specified):	Official action -
VIII-18	Figure of the drawings which should accompany the abstract	
VIII-19	Language of filing of the international application	Finnish
IX-1	Signature of applicant or agent	<i>Hanna-Leena Jyrämä</i>
IX-1-1	Name	FORSSÉN & SALOMAA OY
IX-1-2	Name of signatory	Hanna-Leena Jyrämä

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	10 MAY 2000	(10 -05- 2000)
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PCT REQUEST

HJ/FI991096

Original (for SUBMISSION) - printed on 10.05.2000 11:24:49 AM

10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	30 MAY 2000	30.05.00
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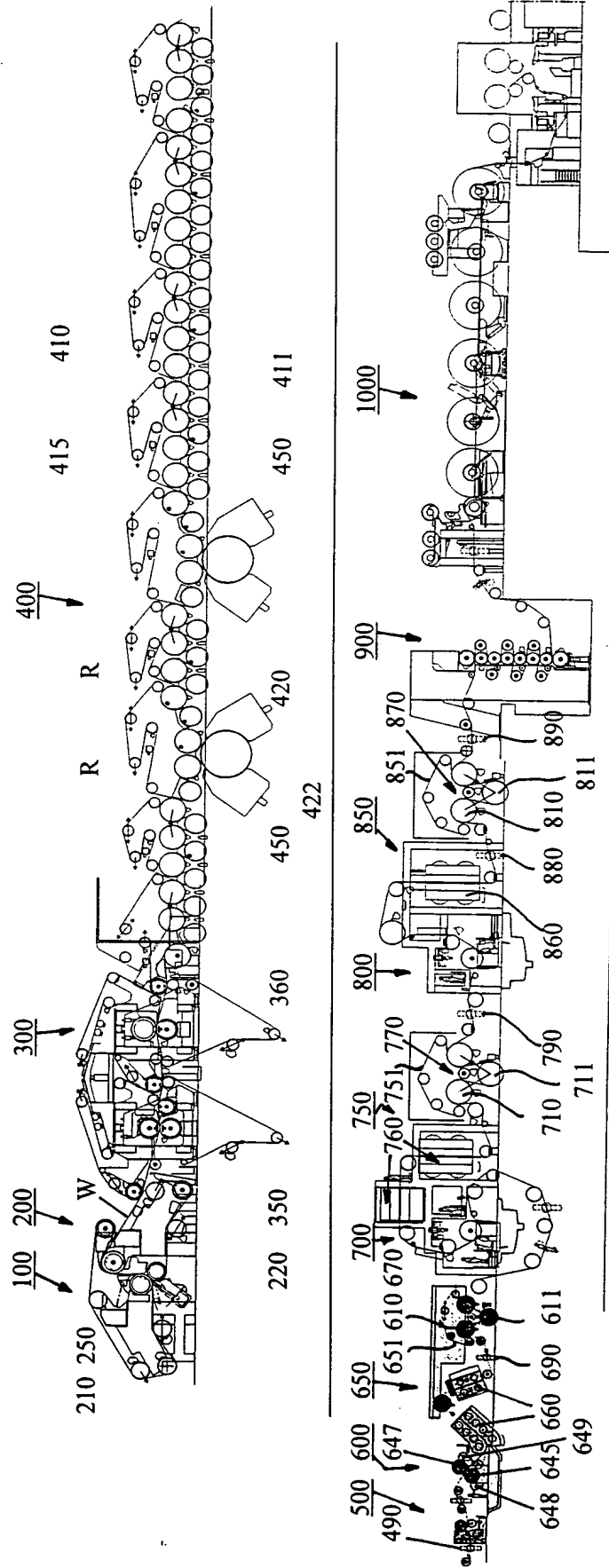


FIG.

Menetelmä paperin, erityisesti hienopaperin, valmistamiseksi
ja paperikonelinja erityisesti hienopaperin valmistamista varten

5

Keksinnön kohteena on patenttivaatimuksen 1 johdanto-osan mukainen menetelmä paperin, erityisesti hienopaperin valmistamiseksi.

- 10 Keksinnön kohteena on myös patenttivaatimuksen 18 johdanto-osan mukainen paperikonelinja erityisesti hienopaperin valmistamista varten.

- Tässä selostuksessa hienopaperilla tarkoitetaan päällystämätöntä hienopaperia ja päällystettyä hienopaperia. Päällystämättömän hienopaperin neliöpaino on tavan-
- 15 omaisesti 40...230 g/m², päällystetyn 60 ... 250 g/m². Tyypillinen massa hienopaperin valmistamiseksi käsittää kemiallista kuitua: lyhytkuitua, jota saadaan esimerkiksi koivusta ja eukalyptuspuusta, ja tähän yleensä lisätään havupuista saatavaa pitkäkuituista ainesta. Mekaanisen massan osuus on yleensä alle 10 %. Massaan lisätään täyteainetta noin 15–30 % ja täyteaine voi olla kalsiumkarbonaattia, kaoliinia ja/tai muita sopivia mineraalipigmenttejä. Viimeaikoina hienopaperin valmistuksessa on ryhdytty myös enenevässä määrin käyttämään kierrätyskuitua.
- 20

Päällystetyn puuvapaan hienopaperin keskeisiä laatuominaisuuksia ovat kiilto, sileys, bulkki, opasiteetti ja vaaleus, tyypillisesti:

- 25 - kiilto on > 70 % (Hunter),
- sileys PPS₁₀ < 1.1, bulkki > 0,8 cm³/g,
- opasiteetti > 92% ja
- vaaleus > 80%.

- Tekniikan tason mukaisilla hienopaperikoneilla kuitenkin harvoin saavutetaan näitä
- 30 kaikkia laatuarvoja yhtä aikaa.

Tekniikan tasosta tunnetuissa paperi- tai kartonkikoneissa lyhytkierto ja muu massajärjestelmä on tavallisimmin rakennettu siten, että se sekoittaa kuidut, täyteaineet, hienoaineet ja lisäaineet mahdollisimman homogeeniseksi massaksi syötettäväksi paperikoneen perälaatikkoon. Monikerrosrainauksessa on tunnettua myös käyttää useita erillisiä massajärjestelmiä eri kuitususpensioiden syöttämiseksi perälaatikkoon. Tekniikan tasosta on tunnettu myös sellainen lyhyt kierto ja perälaatikko, joka mahdollistaa lisäaineiden, täyteaineiden ja/tai hienoihien kerrostamisen. Eräs tällainen keksinnössä edullisesti sovellettava massansyöttöjärjestely on esitetty *FI-patentti-hakemuksessa 934793*. Täyteaineet, hienoihien ja lisäaineet voidaan myös syöttää vasta itse perälaatikossa. Eräs tällainen järjestely on kuvattu *patenttijulkaisussa EP 0 824157*.

Aivan viime aikoina on kehitetty uudentyyppinen, hakijan tavaramerkillä **OptiFeed™** markkinoima lyhyen kierron järjestely, jota on kuvattu mm. lehtiartikkelissa *Ein Neuer Ansatz für das Management der Nasspartie, Wochenblatt für Papierfabrikation vol 19, No 20, October 1998*. OptiFeed -järjestelyä käyttäen minimoituvat lyhyen kierron massatilavuudet, mikä mahdollistaa mm. nopean lajin vaihdon.

Perälaatikko levittää syntyneen massasuspension tasaisesti viiraosalle, jossa alkaa veden poisto ja rainan huopautuminen. Tekniikan tasosta tunnetaan useita erityyppisiä alan ammattimiehelle sinällään tunnettuja viiraosia eli formereita; tasoformereita, hybridiformereita ja kitaformereita. Viime vuosina hienopaperin valmistuksessa on yleistynyt kitaformerit, jossa perälaatikon muodostama huulisuihku ajetaan kahden viiran väliin ja valtaosa vedestä poistetaan mainittujen viirojen välissä kahteen suuntaan. Eräs edullinen kitaformeriratkaisu on kuvattu esitelmässä *L. Verkasalo: Efficient Forming at High Speeds, XI Valmet Paper Technology Days 1998*. Tekniikan tasosta tunnetuista ratkaisuissa kytetään kuitu- ja täyteainejakautumaa rainan paksuussuunnassa rajallisesti hallitsemaan esim. formerin vedenpoistoelementtien sijoittelulla ja alipaineilla. Täyteaineet rikastuvat usein rainan pinnoille vedenpoistovaiheissa.

Tekniikan tasosta tunnetaan myös monikerrosperälaatikoita, jollainen on esitetty esim. esitelmässä *M. Odell: Multilayering, Method or Madness?, XI Valmet Paper Technology Days 1998* sekä *FI-patentissa 92729* ja jollaista on kuvattu myös esitelmässä *P. Ahonen: Challenges for Digital Printing Paper, XI Valmet Paper Technology Days 1998*. Monikerrosperälaatikoilla aikaansaadaan rainaan haluttuja kerrosrakenteita syöttämällä massa kerroksittain viirojen väliin.

Viiraosalta raina viedään puristinosalle, jossa vettä poistetaan rainasta puristamalla sitä yhtä tai kahta huopaa vasten. Tekniikan tasosta ammattimies tuntee useita erilaisia puristinratkaisuja, esimerkiksi hakijan tavaramerkillä **SymPress II™** markkinoiman telanippeihin perustuvan puristimen. Viimeaikoina on kaikilla paperi- ja kartonkilajeilla alettu yhä enenevässä määrin käyttää telanippien sijasta tekniikan tasosta sinänsä tunnettua pitkänippiä sen suuremman vedenpoistokyvyn ja/tai rainan bulkin säilyttämiskyvyn vuoksi.

15

Tekniikan tasosta tunnetuissa hienopaperikoneissa kuivatusosa on tavallisimmin muodostettu konventionaalista yksi- ja/tai kaksiviiravientiä käyttävästä kuivatusosasta, joilla kuivatus tapahtuu pääasiallisesti sylinterikuivatuksena viiran painassa rainaa kuumennettua sylinteripintaa vasten. Suurilla ajonopeuksilla yksiviiravienti koko kuivatusosan läpi on viimevuosina yleistynyt. Uusimpana ratkaisuna on esimerkiksi patenttihakemuksessa *PCT/FI98/00945* esitetty päällepuhalluksen yhdistämistä sylinterikuivatukseen suuremman haihdutusnopeuden ja lyhemmän kuivatusosan aikaansaamiseksi.

Useissa tekniikan tasosta tunnetuissa hienopaperikoneissa kuivatusosalta paperiraina johdetaan esikalanterille, joka tunnetuissa ratkaisuissa voi olla kova- tai pehmeänipinen kalanteri, jossa telojen välisestä nipistä paperiraina johdetaan sileyden aikaansaamiseksi paperirainan pintaan. Viimeaikoina on hienopaperillakin yleistynyt ns. Soft-kalanteri, joka käsittää pehmeän pinnoitetun telan ja kuumen kovapintaisen termotelan. Esikalanterilla myös kiinnitetään irtonaisia kuituja tai muita massan komponentteja rainan pintaan, mutta samalla mahdollisesti aiheutetaan myös tiheyseroja pohjapaperiin sekä menetetään monelle laadulle tärkeitä rainan bulkkisuutta.

30

Tämän jälkeen tekniikan tasosta tunnetuissa hienopaperikoneissa seuraa esipäällystys, esim. pintaliimaus- tai pigmentointiyksikkö. Pintaliimauksessa radan pinnat käsitellään tärkkelys- tai pigmenttiliuoksella filmiliimapuristimessa, esim. hakijan
5 tuotenimellä **SymSizer™** markkinoimalla applikointilaitteella. Pintaliimaus, -pigmentointi, tai -päällystys tehdään tässä vaiheessa tyypillisesti rainan molemmille puolilla samalla kertaa, mutta rainan pinnat voidaan käsitellä myös erikseen peräkkäisissä yksiköissä. Tämän jälkeen paperiraina kuivataan käyttäen infrakuivaimia ja leijukuivaimia sekä näitä seuraavaa sylinteriryhmää tai -ryhmiä ja rullataan kone-
10 rullaimella.

Tämän jälkeen tekniikan tason mukaisessa hienopaperin valmistusprosessissa seuraa aukirullain, jolta rata johdetaan off-machine päällystysasemalle. Tekniikan tasosta tunnetaan erilaisia päällystyslaitteita, kuten esimerkiksi teräpäällys-, jet-, fil-
15 minsiirto- tai spray-tyyppisiä päällystimiä. Päällystinlaitteella päällystysaine siirretään vapaasti rainan pinnalle joko yhtenäisenä suihkuna (jet) tai pisaroina (spray) tai päällyste applikoidaan telalla. Eräässä tunnetussa ratkaisussa suoritetaan ensin paperirainan toisen puolen esipäällystys, jonka jälkeen seuraa kuivatusosa ja tämän jälkeen esipäällystetään paperirainan toinen puoli, mitä seuraa kuivatusosa. Näin ai-
20 kaansaatu esipäällystetty rainan loppupäällystystetään toisilla päällystystekerroksilla ja tämän jälkeen raina kuivataan, ja kiinnirullataan. Päällystysaseman kuivatusosa käsittää tyypillisesti ensin rataa koskettamattoman yksikön, esimerkiksi infrakuivat-
timen, ja sen jälkeisen sylinteriryhmän. Lopuksi raina aukirullataan ja kalanteroidaan superkalanterilla, jolla rainalle annetaan haluttu sileys- ja kiiltotaso. Kiinnirullaus
25 päättää hienopaperikonelinjan. Eräs tekniikan tasosta tunnettu rullain on hakijan tavaramerkillä **OptiReel™** markkinoima rullain.

Keksintöön liittyvän tekniikan tason osalta viitataan myös hakijan *FI-patenttihakemuksiin 981330 ja 981331*. Näissä on FI-patenttihakemuksessa 981330
30 esitetty integroitu paperikone, jolla voidaan valmistaa korkealla hyötysuhteella hyvälaatuista paperia nopeudella, joka ylittää 2000 m/min ja joka on lyhyempi kuin nykyiset paperikoneet.

FI-patenttihakemuksessa 981331 on esitetty paperikone, joka on tarkoitettu erityisesti sellaisen paperin valmistamiseksi, jolla paperilla on kopiopaperiominaisuudet sekä hyvä kiilto ja sopiva huokoisuus värijauhepainatusta varten.

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Eräänä ongelmana tekniikan tasosta tunnetuissa hienopaperikoneissa on erityisesti niiden vaatima tilantarve johtuen pitkästä koneesta sekä se, että lajin vaihtaminen vaatii pitkän ajan. Esimerkiksi käytettäessä perinteistä lyhytkiertoa, vaatii lajinvaihto noin kaksi tuntia. Lisäksi sylinterikuivatusta käytettäessä johtuen sylinterien suuresta
10 lämpökapasiteetista on lämmitystehon muuttaminen hidasta.

Keksinnön päämääränä on luoda menetelmä ja paperikone hienopaperia, erityisesti CWF-hienopaperia eli päällystettyä puuvapaata (Coated Wood Free) hienopaperia varten, jossa operaatiot tapahtuvat on-line. Keksintö soveltuu myös päällystämättö-
15 män puuvapaan hienopaperin (UCWF, UnCoated Wood Free) valmistusta varten käytettäväksi.

Keksinnön päämääränä on saada aikaan menetelmä ja paperikone hienopaperin valmistamiseksi, jossa lajinvaihto on nopeaa. Nopea lajinvaihto mahdollistaa lyhyet
20 toimitusajat, jolloin eri paperilaatuja voidaan asiakkaille toimittaa juuri oikeaan aikaan.

Lisäksi keksinnön päämääränä on aikaansaada menetelmä ja paperikone hienopaperin valmistamiseksi, joka mahdollistaa erilaiset profilointijärjestelyt.
25

Keksinnön yhteydessä on erityisesti huomattava, että useat keksinnön mukaisessa menetelmässä ja paperikoneessa käytettävät tekniikat ovat erikseen tulleet tunnetuiksi vasta aivan viimeaikoina eri paperi- tai kartonkilaatujen yhteydessä. Tässä keksinnössä uusista teknologioista on oivallettu koota hienopaperikonelinja, joka tuottaa
30 korkealaatuista hienopaperia hyvällä hyötysuhteella.

Edellä esitettyjen ja myöhemmin esille tulevien päämäärien saavuttamiseksi on keksinnön mukaiselle menetelmälle pääasiallisesti tunnusomaista se, mitä on esitetty patenttivaatimuksen 1 tunnusmerkkiosassa.

- 5 Keksinnön mukaiselle paperikonelinjalle on puolestaan pääasiallisesti tunnusomaista se, mitä on esitetty patenttivaatimuksen 18 tunnusmerkkiosassa.

Keksinnön mukaisesti rakennetaan hienopaperin valmistuslinja kokonaisvaltaisesti. Keksinnössä käytetään edullisimmin hakijan tavaramerkillä **OptiFeed™** markkinoimaa tai vastaavan tyyppistä lyhytkertojärjestelyä, jollainen on kuvattu *FI-patenttihakemuksessa nro 981327*, jossa osamassojen laimennusannostelu sakeuteen tapahtuu ennen osamassojen annostelusäiliöitä, neliömassan säätö tapahtuu osamassojen annostelusäiliöstä osamassojen virtaussäätöjen avulla ja laimennusperälaatikko sakeuteen tapahtuu kahdessa vaiheessa, joista ensimmäisessä on vakiovirtaus ja toisessa virtausta säädetään perälaatikon paineen säädöstä saatavalla ohjaussignaalilla.

15 Tällainen lyhytkierto, jossa on minimoitu lyhyen kierron tilavuutta, mahdollistaa nopean lajinvaihdon, koska siinä käytetään vähän massaa ja siitä on jätetty ylimääräisiä sekoitusvaiheita pois. Lisäksi tällaisessa lyhytkiertoprosessissa käytetään runsaasti automaatiota, mikä edelleen edesauttaa sitä, että lajinvaihto voidaan lyhentää

20 tunnista muutamaan kymmeneen sekuntiin. Esimerkiksi 15 %:n neliömassan muutos perinteistä lyhytkiertoa soveltaen vie muutamia kymmeniä minuutteja, kun **OptiFeed™**-tyyppistä järjestelyä käytettäessä päästään muutamaan kymmeneen sekuntiin.

- 25 Perälaatikkona keksinnössä käytetään hakijan tavaramerkillä **OptiFlo™** markkinoimaa tai vastaavan tyyppistä perälaatikkoa, jossa neliömassaprofiili voidaan säätää sakeussäätöisesti ja voidaan vaikuttaa kuituorientaatioon profiilia säätämällä. Perälaatikossa voidaan käyttää kerrostusta lisä- tai täyteainekerrostamista, minkä osalta voidaan viitata esim. hakijan *EP-patenttiin 651 092*.

30

Formerina käytetään kitaformeria, joka sallii suuremmat nopeudet kuin muun tyyppiset formerit ja suorittaa vedenpoiston kaksipuolisesti, jolloin saadaan symmetristä

paperia. Eräänä tällaisena kitaformerina voidaan mainita esimerkiksi hakijan tavaramerkillä **OptiFormer™** markkinoima viiraosa tai vastaavan tyyppinen formeri, jollainen on kuvattu mm. esitelmässä *L. Verkasalo: Efficient Forming at High Speeds, XI Valmet Paper Technology Days 1998*.

5

Keksinnön mukaisessa hienopaperin valmistuslinjassa hyödynnetään pitkänippipuristusta. Ns. kenkäpuristimella saavutetaan hyvä bulkki ja korkea kuiva-aine ja mahdollisimman pieni epäsymmetria rataa. Käytettäessä esimerkiksi hakijan kaksihuopaista **OptiPress™** – puristinosaa saavutetaan symmetrinen vedenpoisto ja pintaominaisuuksiltaan symmetrinen raina. Pyrittäessä korkeisiin kuiva-aineisiin saattaa toinen huopa olla edullista korvata vettä vastaanottamattomalla ja rainaa hyvin siirtävällä kudoksella, ns. siirtohihnalla.

Keksinnössä kuivatusosalla käytetään sekä sylinteri- että päällepuhalluskuivatusta, jollainen kuivatusosa on esitetty esimerkiksi kansainvälisessä patenttihakemuksessa *PCT/FI98/00945*. Edullisesti käytetään esim. hakijan tavaramerkillä **OptiDry™** markkinoimaa tai vastaavan tyyppistä kuivatusosaa. Tällaisessa kuivatusosassa, missä sylinterikuivatuksen lisäksi käytetään päällepuhalluskuivatusta, on lajinvaihto nopeaa, koska päällepuhallusparametrien muuttaminen on huomattavasti nopeampaa kuin massiisisten kuivatussylinterien lämpötilan muuttaminen. Päällepuhallus mahdollistaa myös tehokkaamman kosteusprofiilin hallinnan kuin perinteinen sylinterikuivatus yksinään.

Haluttaessa kuivatusosalla voidaan käyttää esikalanterointia, jollainen on esitetty esimerkiksi *FI-patenttihakemuksessa 960925*, jossa on esitetty kalanterointikuivatus sylinteriä vasten. Esikalanterointi voidaan suorittaa myös kahden telan välissä. Luonnollisesti esikalanterointi voidaan tarvittaessa tehdä myös perinteisesti kuivatusosan jälkeen. Tällöin kalanteri on joko kovanippikalanteri tai softkalanteri. Myös pitkänippikalanteria voidaan hyödyntää edullisesti keksinnön mukaisessa järjestelyssä. Riippumatta siitä, missä esikalanteri sijaitsee, kalanteroinnissa käytetään keksinnön mukaisesti suhteellisen pieniä kuormia, esim. alle 80 kN/m. Näin voidaan säästää hienopaperin erästä tärkeitä ominaisuutta, bulkkia. Toisaalta keksinnön mu-

kaisen hienopaperikoneen märkää, joka tekee symmetristä paperia, mahdollistaa alhaiset viivakuormat kalanterissa.

Keksinnön mukaisessa hienopaperikonelinjassa seuraa esikalanteroinnin jälkeen
5 esipäällystys. Esipäällistykseen tehtävänä on pienentää pohjapaperin pintarakenteessa olevia huokosia sopivasti, jotta varsinainen pintapäällyste jää pintaan eikä uppoa paperin rakenteeseen. Esipäällistyksessä käytetään hakijan tavaramerkeillä **SymSizer™** tai **OptiSizer™** markkinoimaa tai vastaavan tyyppistä pintaliimaus-/pigmentointiyksikköä, joilla voidaan profiloida pintaliiman/pigmentin määrä.

10

Esipäällistystä seuraa pääasiallisesti kosketuksetonta kuivatusta soveltava kuiva-
tusosuus, mikä mahdollistaa nopean lajinvaihdon. Kosketuksetonta kuivatusta seuraa
lyhyt sylinteriryhmä, jolla sinänsä vaikutetaan ensisijaisesti rainan kulun stabiloin-
tiin, radan vetoon ja kireyteen samalla kun jatketaan kuivausta. Sylinteriryhmä voi
15 olla yksi- tai kaksiviiravienttiä, edullisimmin kuitenkin yksiviiravienttiä. Kosketta-
mattoman kuivatuksen yhteydessä voidaan käyttää hakijan tavaramerkillä **TurnDry™**
markkinoimaa tai vastaavan tyyppistä kuivatusta, jossa paperirainaa kuivataan ja
käännetään samalla laitteella esimerkiksi yhdistelmällä kääntölaite ja
leijukuivain. Tämä mahdollistaa nopean lajinvaihdon ja samalla varmistaa rainan
20 stabiilin kulun.

Päällistyksessä käytetään sopivaa päällistysasemaa esimerkiksi teräpäällystintä, jet-
tai spray-tyyppistä päällistyslaitetta. Keksinnössä edullisesti päällystinlaitteella
päällistysaine siirretään vapaasti rainan pinnalle joko yhtenäisenä suihkuna (jet) tai
25 pisaroina (spray). Edullisesti käytetään hakijan tavaramerkillä **OptiCoat Jet™**
markkinoimaa tai vastaavan tyyppistä päällistyslaitetta.

Ratakatkojen eliminoimiseksi raina voidaan päällistää hihnan tukemana. Tuettu
päällistys on esitetty esimerkiksi hakijan suomalaisessa patentissa *FI 101489* sekä
30 artikkelissa *1998 Coating/Paper Machine Makers Conferens, TAPPI Proceedings*.

Päällystyksen jälkeisessä kuivatus aloitetaan koskettamattomalla kuivatuksella, esim. hakijan tavaramerkillä **PowerDry™** markkinoimalla tai vastaavan tyyppisellä kuivatimella, jolla aikaansaadaan suuri kuivatusteho ja tarvittaessa nopea kuivatustehon muutos. Itse asiassa kosketukseton kuivaus on usein pääasiallinen kuivatusmuoto
5 niin, että sitä seuraava lyhyt sylinteriryhmä toimii pääasiallisesti vetoryhmänä. Pintaliimauksen ja/tai päällystyksen jälkeiset kuivatusvaiheet varustetaan edullisesti profilointilaitteella, jolloin paperirainan kuivatuksen profilointi jälkikuivatusvaiheissa on mahdollista. Keksinnön mukaisen hienopaperikonelinjan jokin kuivatusosa voidaan varustaa myös esim. tekniikan tasosta tunnetuilla höyrytys tai kostustuslaitteilla paperirainan käyristymisen hallitsemiseksi ja säätämiseksi.
10

Tämän jälkeen seuraa on-line moninippikalanteri, esim. hakijan tavaramerkillä **OptiLoad™** markkinoima tai vastaavan tyyppinen kalanteri, joka poikkeaa tavanomaisista superkalantereista siinä, että sen viivakuormat kussakin nipissä voidaan erikseen säätää. Näin on mahdollista säästää bulkkia, mutta saavuttaa hyvä
15 kiilto ja sileys. Tämän tyyppisen kalanterin osalta viitataan *FI-patenttiin 96334*.

Keksinnön mukainen hienopaperikonelinja päättyy rullaimeen. Se on sopivimmin hakijan tavaramerkillä **OptiReel™** markkinoima tai sen tyyppinen rullain, joka saavutetaan alhaiset pohjahylyn määrät ja korkeatasoinen rulla sen jatkokäsittelyn ongelmatomuuden varmistamiseksi.
20

Keksinnön mukaiseen menetelmään ja paperikoneeseen hienopaperin valmistamiseksi on yhdistetty sopivia automaatio- ja mittalaitteita esimerkiksi rainan pituus- ja
25 poikkisuuntaisten profiilien määrittämiseksi ja korjaamiseksi tai nopean lajimuutoksen toteuttamiseksi. Mittalaitteena käytetään esimerkiksi poikkipalkkia, jossa on useita sensoreita tai skannereita ja samalla voidaan mitata konesuuntaista vaihtelua esimerkiksi skannauslaitteilla.

30 Yhteenvedonomaaisesti voidaan todeta, että keksinnössä on onnistuttu yhdistämään samaan konseptiin hienopaperin valmistuslinjan ne oleelliset tekijät, joilla voidaan aikaansaada korkea paperilaatu ja nopea lajinvaihto. Näitä tekijöitä ovat erityisesti,

että käytetään nopean lajin vaihdon mahdollistavaa lyhyttä kiertoa ja formerina kita-formeria, joka sallii suuremmat nopeudet kuin muun tyyppiset formerit ja mahdollisuuden suorittaa vedenpoiston kaksipuolisesti, jolloin saadaan symmetristä paperia. Lisäksi keksinnössä edullisesti käytettävällä kaksihuopaisella kenkäpuristimella saavutetaan hyvä bulkki ja korkea kuiva-aine ja mahdollisimman pieni epäsymmetria-
5 rataa. Kuivatusosalla ainakin osa kuivatusosasta on muodostettu päällepuhalluskuivatuksesta, mikä mahdollistaa nopean lajinvaihdon. Kalanterilla käytetään alhaisia nippikuormia ja pintaliimaus/pigmentointi -vaiheessa käsitellään molemmat pinnat yhtä aikaa. Jälkikuivatusosalla on kombinoitu sylinterikuivatus ja rataa kosket-
10 tamaton kuivatus, joka osaltaan mahdollistaa nopean lajinvaihdon. Pintakäsittelyyksiköissä paperi käsitellään molemmilta puoliltaan, jonka jälkeen seuraava kuivatusosa on jälleen valtaosaltaan koskettamatonta kuivatusta. Kalanteri on on-line moninippikalanteri, jossa viivakuormat kussakin nipissä ovat säädettävissä erikseen. Tällä tavalla saavutetaan haluttu kiilto- ja sileystaso bulkin silti säilyessä.

15

Keksinnössä profilointimahdollisuuden takaa se, että laitteina käytetään profiloivia laitteita. Neliömassa voidaan profiloida perälaatikon sakeussäädöllä. Puristinosalla voidaan käyttää höyrylaatikkoa kuiva-aineen nostoon sekä profilointiin. Päällepuhallus mahdollistaa kuivatuksen profiloinnin. Kuivatusosalla voidaan myös käyttää
20 kostutuslaitetta kuiva-aineen profilointiin ja sizer-tyyppisillä päällystimillä voidaan profiloida pintaliimaa/päällystemäärää. Rataa koskettamattoman kuivatuksen yhteyteen on helppo yhdistää profilointia ja tarvittaessa ennen kalanteria voidaan käyttää esim. höyry- tai vesisumperusteista kostutuslaitetta, jolla voidaan profiloida rainan kosteutta sekä vaikuttaa käyristymään.

25

Keksinnön yhteydessä voidaan käyttää paperirainan käyristymän säätöä, joilta osin viitataan *FI-hakemuksiin 906216, 950434, 964830 ja 972080*.

Seuraavassa keksintöä selostetaan yksityiskohtaisemmin oheisen piirustuksen kuvio-
30 on viitaten, jonka yksityiskohtiin keksintöä ei ole kuitenkaan tarkoitus mitenkään ahtaasti rajoittaa. Keksintöä ei myöskään ole tarkoitettu rajattavaksi vain tähän sinänsä edulliseen suoritusmuotoon.

Kuviossa on kaaviollisesti esitetty keksinnön mukaisen paperikoneen eräs sovellus. Siinä ei ole esitetty keksinnön mukaisen hienopaperikoneen lyhyttä kiertoa tai muuta massajärjestelyä. Niiden osalta viitataan aiemmin mainittuun lehtiartikkeliin *Ein*
5 *Neuer Ansatz f'ur das Management der Nasspartie, Wochenblatt fur Papierfabrikation* vol 19, No 20, October 1998 ja patentihakemukseen FI 981327.

Kuvion mukaisesti perälaatikosta 100 massa syötetään viiraosalle 200, jossa sijaitsee kitaformerin 250, joka poistaa vettä kaksipuolisesti. Puristinosalla 300 ainakin yksi
10 puristinnippi on pitkänippipuristin. Kuvion puristimessa ensimmäinen nippi 350 on telanippi ja toinen nippi 360 pitkänippi, edullisesti kenkäpuristin, joka säästää bulkkia ja vähentää toispuoleisuutta paperin veden poistossa. Puristinosalta 300 raina W johdetaan etukuivatusosalle 400, jossa kuvion mukaisessa sovelluksessa käytetään yksiviiravientiryhmiä R sekä päällepuhalluskuivatusta 450. Kuvion mukaisessa so-
15 velluksessa päällepuhalluskuivatusyksiköt 450 on muodostettu kellaritilaan sijoitusta suurihalkaisijaisesta sylinteristä 420 ja sen yhteyteen sijoitetusta päällepuhalluskuivatuslaitteistosta 422. Etukuivatusosan 400 jälkeen seuraa mittaraami 490 mm. rainan poikkiprofiilien mittaamiseksi. Kalanteri 500 on kuvion esimerkissä soft-
20 kalanderi. Sitä seuraa tela-applikointia soveltavaan filminsiirtoon perustuva esipölystysasema 600 rainan pintaliimaamiseksi/pigmentoimiseksi ja jälkikuivatusryhmä 650, joka muodostuu pääasiallisesti kosketuksetonta kuivatusta (infrakuivatus, leijukuivatus) soveltavasta osuudesta 660 ja lyhyestä sylinteriryhmästä 670. Tämän jälkeen raina päällystetään päällystysasemilla 700,800, jossa ensin päällystetään ensimmäisellä päällystysasemalla 700 rainan ensimmäinen puoli, joka kuivatetaan kuivatusyksikössä 750, pääasiallisesti kosketuksetonta kuivatusta 760 käyttäen, jonka
25 jälkeen seuraa lyhyt sylinteriryhmä 770. Toisella päällystysasemalla 800 päällystetään rainan toinen puoli, jota seuraa kuivatusosuus 850, jossa pääasiallisesti sovelletaan kosketuksetonta kuivatusta 860, jota jälleen seuraa lyhyt sylinteriryhmä 870. Tämän jälkeen seuraa kalanderi, jossa paperirainaan kalanderoidaan haluttu kiilto ja
30 sileys moninippikalanderissa 900, jossa edullisesti kunkin nipin kuormituspaine on erikseen säädettävissä. Lopuksi rainasta tehdään rullia rullaimella 1000.

Kuvion mukaisessa paperikoneessa paperirainan W kulku on seuraavaa. Perälaatikosta 100 massa syötetään viiraosan 200 kitaformerin 250 formeritelojen 210,220 väliseen kitaan, josta se johdetaan viirojen välissä kitaformerin 250 vedenpoistolaitteiden ohi edelleen viiran tukemana puristinosalle 300. Puristinosa 300 käsittää kaksi puristinta 350 ja 360. Ensimmäisen puristimen yläkudoksella raina W johdetaan puristimen 350 puristintelojen väliin alakudoksen tukemana. Alakudokselta raina W johdetaan seuraavan puristimen 360 yläkudokselle ja edelleen yläkudoksen ja alakudoksen välissä puristimen 360 puristintelojen väliin. Puristinosalta 300 raina W johdetaan kuivatusosaan 400, jossa raina W kuivatusviirojen tukemana päällepuhalluskuivatusryhmissä 450 ja yksiviiravientiä soveltavissa kuivatusryhmissä R. Yksiviiravientiä soveltavien kuivatusryhmien R kuivatusviiraa on merkitty viitenumerolla 415 ja ylärivin kuumennettuja kuivatussylinterejä viitenumerolla 410 ja alarivin kääntösylinterejä tai teloja viitenumerolla 411. Raina W kulkee polveillen alarivin kääntösylintereiltä/-teloilta 411 ylärivin kuumennetuille kuivatussylintereille 410, joilla raina W on suoraan kontaktissa kuumennettua sylinteripintaa vasten. Edellä kuvatut merkinnät on tehty selvyuden vuoksi vain yhden kuivatusryhmän kohdalle. Tämän jälkeen raina W johdetaan mittalaitteen 490 kautta kalanterille 500. Esipäällystysyksikön 600 teloja on merkitty viitenumeroilla 645 ja 647 sekä filminsiirtolaitteistoja viitenumeroilla 648 ja 649. Ensimmäinen kosketuksettoman kuivatus- ja kääntölaitteen 660 kautta raina W johdetaan toisen kosketuksettoman kuivatuslaitteen esim. infra-/leijukuivaimen 660 ohi yksiviiravientiä soveltavaan kuivatusryhmään 670, joka käsittää kuivatusviiran 651 ja kuumennetut kuivatussylinterit 610 sekä kääntösylinterit/-telat 611. Tämän jälkeen raina päällystetään päällystysasemilla 700,800, joissa raina johdetaan päällystysasemalta 700;800 kosketuksetonta kuivatusta soveltaviin kuivatuslaitteistoihin 760;860, joita seuraa yksiviiravientiä soveltava kuivatusryhmä 770;870, joka käsittää kuivatusviiran 751,851, kuumennetut kuivatussylinterit 710,810 sekä kääntösylinterit/-telat 711,811. Esipäällystysosaa 600 seuraa mittalaite 690, joka sijoitettu kosketuksetonta kuivatusta soveltavan osuuden 660 ja sylinteriryhmän 670 väliin. Lisäksi kummankin päällystysaseman 700,800 jälkeen on sijoitettu mittalaite 790,890. Lisäksi jälkimmäisen päällystysryhmän yhteyteen on sijoitettu mittalaite 880 myös ennen sylinteriryhmää 870. Sen jälkeen

raina W johdetaan on-line moninippi -kalanteriin 900. Kalanterin 900 jälkeen raina W johdetaan rullaimelle 1000, jossa paperiraina W rullataan paperirulliksi.

5 Keksintöä on edellä selostettu vain erääseen sen edulliseen sovellusesimerkkiin viitaten, jonka yksityiskohtiin keksintöä ei ole kuitenkaan tarkoitus mitenkään ahtaasti rajoittaa. Monet muunnokset ja muunnelmat ovat mahdolliset seuraavien patenttivaatimusten määrittelemän keksinnöllisen ajatuksen puitteissa.

Patenttivaatimukset

1. Menetelmä paperin, erityisesti hienopaperin valmistamiseksi, jossa menetelmässä paperimassa syötetään perälaatikosta (100) viiraosalle (200), jolla paperirainasta (W)
- 5 poistetaan vettä, jossa menetelmässä paperiraina (W) johdetaan viiraosalta (200) puristinosalle (300) veden puristamiseksi paperirainasta (W), ja jossa menetelmässä puristinosan (300) jälkeen paperiraina (W) kuivataan kuivatusosalla (400), esikalanteroidaan ja esipäällystetään esipäällystimellä (600), minkä jälkeen paperiraina (W) kuivataan kuivatusosuudella (650) ja päällystetään päällystysasemalla/-asemilla
- 10 (700,800),
- minkä jälkeen paperiraina (W), kuivataan kuivatusosuudella/-osuuksilla (750,850), kalanteroidaan kalanterissa (900) ja rullataan rullaimella (1000), **tunnettu** siitä, että menetelmässä
- massa syötetään perälaatikkoon (100) lyhyestä kierrosta, jonka massatilavuus on minimoitu,
 - 15 - viiraosalla (200) paperirainasta (W) poistetaan vettä, formerissa, edullisimmin kitaformerissa (250),
 - puristinosalla (300) paperirainasta (W) puristetaan vettä ainakin yhdessä pitkänippipuristimessa (360),
 - 20 - kuivatusosalla (400) ainakin osa paperirainan (W) kuivatuksesta suoritetaan päällepuhalluskuivatuksella (450),
 - paperirainaa (W) esikalanteroidaan kalanterissa (900) käyttäen alhaisia nip-pikuormia,
 - paperirainan (W) molemmat pinnat esipäällystetään yhtä aikaa,
 - 25 - esipäällystyksen (500) jälkeen paperirainaa (W) kuivataan kosketuksettomalla kuivatuksella (660),
 - paperiraina (W) päällystetään on-line päällystysasemalla/-asemilla (700,800), jonka jälkeen paperirainaa (W) ainakin osittain kuivataan kuivatusosuudella/-osuuksilla (750,850) paperirainaa (W) kosketuksettomasti, ja
 - 30 - paperirainaa (W) kalanteroidaan on-line kalanterissa (900) säätäen viiva-kuormaa kussakin nipissä erikseen.

2. Patenttivaatimuksen 1 tai mukainen menetelmä, **tunnettu** siitä, että menetelmässä perälaatikossa (100) neliömassaprofiilia säädetään sateussäätöisesti paperirainan (W) kuituorientaation vaikuttamiseksi profiilia säätämällä.
- 5 3. Patenttivaatimuksen 1 mukainen menetelmä, **tunnettu** siitä, että menetelmässä pitkänippipuristimena (350,360) käytetään kenkäpuristinta.
4. Patenttivaatimuksen 1 mukainen menetelmä, **tunnettu** siitä, että puristinosalla (300) käytetään puristinnipeissä kahta huopaa tai huopaa ja siirtohihnaa.
- 10 5. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä esipäällystyksessä (600) profiloidaan käytettävän pintaliiman/pigmentin määrää.
- 15 6. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä paperin kuivatukseen sovelletaan päällepuhalluksen ja sylinterikuivatuksen tai rataa koskettamattoman kuivatuksen ja sylinterikuivatuksen kombinaatioita nopean lajin vaihdon toteuttamiseksi.
- 20 7. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä esipäällystyksen (600) päällystyksen (700,800) jälkeen suoritettavan koskettamattoman kuivatuksen yhteydessä paperirainan kuivatusta profiloidaan profiointilaitteella.
- 25 8. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä päällystyksessä (700,800) käytetään terä-, jet- tai spray-tyyppistä päällystyslaitetta.
9. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että
- 30 menetelmässä paperirainaa (W) mitataan poikkipalkkiin kiinnitetyillä sensoreilla paperirainan (W) ominaisuuksien valvomiseksi ja että menetelmässä mittaustulosten perusteella ohjataan paperirainan (W) ominaisuuksien profiointia.

10. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä kuivatusosalla (400) paperirainan kuivatusta profiloidaan päällepuhaluskuivatusta käyttäen.
- 5
11. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä käytetään ennen kalanteria (900) sijoitettua höyry- tai vesisumuperusteista kostutuslaitetta käyristymän profiloimiseksi.
- 10
12. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä kuivatusosalla käytetään esikalanterointia sylinteriä tai telaa vasten.
13. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä paperikoneen loppuosalla paperirainaa (W) tuetaan hihnoilla.
- 15
14. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä jälkikuivatusyksiköissä pääasiallinen kuivatus tehdään rataa koskettamattomasti.
- 20
15. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä esikalanterissa (500) käytetään alhaisia viivakuormia, edullisesti alle 80 kN/m.
16. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että
- 25
- menetelmässä esikalanterointi suoritetaan pitkänippikalanteria käyttäen.
17. Jonkin edellisen patenttivaatimuksen mukainen menetelmä, **tunnettu** siitä, että menetelmässä hienopaperia valmistetaan käyttäen kuitujen ja /tai lisäaineiden ja /tai täyteaineiden kerrostusta.
- 30
18. Paperikonelinja erityisesti hienopaperin valmistamiseksi, joka linja käsittää lyhyen kierron, perälaatikon (100), viiraosan (200), puristinosan (300), kuivatusosan

(400), esikalanterin (500), esipäällystimen (600) ja sen jälkeisen kuivatusosuuden (650), päällystysaseman/-asemat (700,800) ja jälkikuivatusosan/ -osat (750,850), kalanterin (900) ja rullaimen (1000), **tunnettu** siitä, että paperikonelinja käsittää lyhyen kierron, jonka massatilavuus on minimoitu, että viiraosa (200) käsittää formerin (250), että puristinosa (300) käsittää ainakin yhden pitkänippipuristimen (360), että kuivatusosasta (400) ainakin osa perustuu päällepuhalluskuivatukseen (450), että paperirainan (W) esipäällystin (600) on kaksipuoleinen ja että paperikonelinja edelleen käsittää on-line päällystysaseman/-asemat (700,800) ja sen niiden jälkeisen/jälkeiset pääasiallisesti kosketuksettomaan kuivatukseen perustuvat kuivatusosuuden/-osuudet (750,850), ja että paperikonelinjassa on on-line kalanteri (900), jossa viivakuormat kussakin nipissä on säädettävissä erikseen.

19. Patenttivaatimuksen 18 mukainen paperikonelinja, **tunnettu** siitä, että on-line kalanteri on moninippikalanteri.

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20. Patenttivaatimuksen 18 tai 19 mukainen paperikonelinja, **tunnettu** siitä, että perälaatikko (100) on monikerrosperälaatikko

21. Patenttivaatimuksen 18–20 mukainen paperikonelinja, **tunnettu** siitä, että viiraosana on kitaformerin.

22. Jonkin patenttivaatimuksen 18–21 mukainen paperikonelinja, **tunnettu** siitä, että puristinosan jälkimmäinen nippi (360) on pitkänippipuristin.

23. Jonkin patenttivaatimuksen 18–22 mukainen paperikonelinja, **tunnettu** siitä, että puristinosassa puristinnipeissä on kaksi huopaa tai huopa ja siirtohihna.

24. Jonkin patenttivaatimuksen 18–23 mukainen paperikonelinja, **tunnettu** siitä, että päällystin (700,800) on terä-, jet- tai spray-tyyppinen päällystyslaite.

30

25. Jonkin patenttivaatimuksen 18–24 mukainen paperikonelinja, **tunnettu** siitä, että sen kuivatusosuudet (400,600,750,850) käsittävät kombinaationa sekä sylinterikuivatusta että päällepuhalluskuivatusta tai sylinterikuivatusta ja rataa koskettamattomasti kuivatusta.
- 5
26. Jonkin patenttivaatimuksen 18–25 mukainen paperikonelinja, **tunnettu** siitä, että sen jälkikuivatusosuudet (600,750,850) on mitoitettu siten, että pääasiallinen kuivatus tapahtuu rataa koskettamattomasti.
- 10
27. Jonkin patenttivaatimuksen 18–26 mukainen paperikonelinja, **tunnettu** siitä, että paperikonelinja käsittää ennen kalanteria sijoitetun höyry- tai vesisumuperusteisen kostutuslaitteen käyristymän profiloimiseksi.
- 15
28. Jonkin patenttivaatimuksen 18–27 mukainen paperikonelinja, **tunnettu** siitä, että kuivatusosa käsittää esikalanterointilaitteen sylinteriä tai telaa vasten.
29. Jonkin patenttivaatimuksen 18–28 mukainen paperikonelinja, **tunnettu** siitä, että paperikoneen loppuosa käsittää paperirainan hihnattentaa.
- 20
30. Jonkin patenttivaatimuksen 18–29 mukainen paperikonelinja, **tunnettu** siitä, että paperikonelinjan esikalanterina on soft – tai pitkänippikalanteri.

Tiivistelmä

Esillä olevan keksinnön kohteena on menetelmä paperin, erityisesti hienopaperin valmistamiseksi. Menetelmässä paperimassa syötetään perälaatikosta (100) viiraosalle (200) veden poistamiseksi paperirainasta, paperiraina (W) johdetaan viiraosalta (200) puristinosalle (300) veden puristamiseksi paperirainasta (W), puristinosan (300) jälkeen paperiraina (W) kuivataan kuivatusosalla (400), esikalenteroidaan ja esipäällystetään esipäällystimellä (600), minkä jälkeen paperiraina (W) kuivataan ja päällystetään, minkä jälkeen paperiraina (W), kuivataan, kalanteroidaan ja rullataan. Keksinnön mukaisesti menetelmässä massa syötetään perälaatikkoon (100) lyhyestä kierrosta, jonka massatilavuus on minimoitu, paperirainasta (W) poistetaan vettä edullisimmin kitaformerissa (250), puristinosalla (300) paperirainasta (W) puristetaan vettä pitkänippipuristimessa (360), kuivatusosalla (400) paperirainan (W) kuivatukseen käytetään päällepuhalluskuivatusta (450), paperirainaa (W) esikalenteroidaan kalanterissa (900) käyttäen alhaisia nippikuormia, paperirainan (W) molemmat pinnat esipäällystetään yhtä aikaa, esipäällystyksen (500) jälkeen paperirainaa (W) kuivataan kosketuksettomalla kuivatuksella (660), paperiraina (W) päällystetään on-line päällystysasemalla/-asemilla (700,800), jonka jälkeen paperirainaa (W) ainakin osittain kuivataan kuivatusosuudella/-osuuksilla (750,850) paperirainaa (W) kosketuksettomasti, ja paperirainaa (W) kalanteroidaan on-line kalanterissa (900) säätäen viivakuormaa kussakin nipissä erikseen. Keksinnön kohteena on myös paperikonelinja erityisesti hienopaperin valmistamiseksi. Linja käsittää lyhyen kierroksen, perälaatikon (100), viiraosan (200), puristinosan (300), kuivatusosan (400), esikalanterin (500), esipäällystimen (600) ja sen jälkeisen kuivatusosuuden (650), päällystysaseman/-asemat (700,800) ja jälkikuivatusosan/-osat (750,850), kalanterin (900) ja rullaimen (1000). Keksinnön mukaisesti paperikonelinja käsittää lyhyen kierron, jonka massatilavuus on minimoitu, viiraosa (200) käsittää kitaformerin (250), puristinosa (300) käsittää pitkänippipuristimen (360), kuivatusosasta (400) ainakin osa perustuu päällepuhalluskuivatukseen (450), paperirainan (W) esipäällystin (600) on kaksipuoleinen. Edelleen paperikonelinja käsittää keksinnön mukaisesti on-line päällystysaseman (700,800) ja sen jälkeisen kosketuksettomaan kuivatukseen perustuvan kuivatusosuuden (750,850), ja paperikonelinjassa on on-line kalanteri (900), jossa viivakuormat kussakin nipissä on säädettävissä erikseen. (FIG.)



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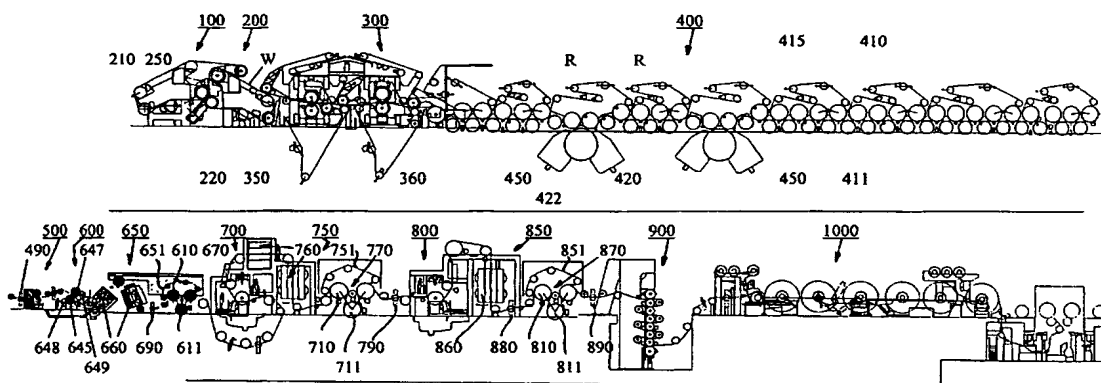
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(54) Title: METHOD FOR THE MANUFACTURE OF PAPER, AND PAPER MACHINE LINE



(57) Abstract

The present invention relates to a method for the manufacture of paper, in particular of fine paper. In the method, paper stock is fed from a headbox (100) to a wire section (200) to drain water from a paper web, the paper web (W) is passed from the wire section (200) to a press section (300) to press water out of the paper web (W), after the press section (300), the paper web (W) is dried in a dryer section (400), precalendered and precoated in a precoater (600), after which the paper web (W) is dried and coated, after which the paper web (W) is dried, calendered and reeled. In accordance with the invention, in the method, the stock is fed into the headbox (100) from a short circulation the stock volume of which has been minimized, water is removed from the paper web (W) most advantageously in a gap former (250), in the press section (300) water is pressed out of the paper web (W) in an extended nip press (360), in the dryer section (400) impingement drying (450) is employed for the drying of the paper web (W), the paper web (W) is precalendered in a calender (900) employing low nip loads, both surfaces of the paper web (W) are precoated at the same time, after precoating (500) the paper web (W) is dried by means of contact-free drying (660), the paper web (W) is coated in an on-line coating station/stations (700, 800), after which the paper web (W) is at least partly dried in a drying section/sections (750, 850) by means of contact-free drying of the paper web (W), and the paper web (W) is calendered in an on-line calender (900) while the linear load in each nip is regulated separately. The invention also relates to a paper machine line in particular for the manufacture of fine paper.

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METHOD FOR THE MANUFACTURE OF PAPER, AND PAPER MACHINE LINE

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The invention relates to a method for the manufacture of paper, in particular of fine paper, according to the preamble of claim 1.

10

The invention also relates to a paper machine line in particular for the manufacture of fine paper according to the preamble of claim 18.

In this description, by fine paper is meant uncoated fine paper and coated fine paper.

15 The basis weight of uncoated fine paper is usually 40 to 230 g/m², that of coated fine paper 60 to 250 g/m². Typical pulp for the manufacture of fine paper comprises chemical fibres: short fibres which are obtained, for example, from birch and eucalyptus, and a long-fibre material obtained from softwood trees is generally added to this. The proportion of mechanical pulp is generally below 10 %. About 15 to 30
20 % of filler is added to the pulp, and the filler may be calcium carbonate, kaolin and/or other suitable mineral pigments. Recently, in the manufacture of fine paper, increasing use has also been made of recycled fibres.

The essential quality properties of coated woodfree fine paper include gloss, smoothness, bulk, opacity, and brightness, typically:

- gloss is > 70 % (Hunter),
- smoothness PPS₁₀ < 1.1, bulk > 0.8 cm³/g
- opacity > 92 %, and
- brightness > 80 %.

30 However, all of these quality values are seldom achieved at the same time on fine paper machines according to the state of the art.

In paper or board machines known in prior art, the short circulation and other stock systems are most commonly built such as to mix fibres, fillers, fines and additives to form a stock that is as homogeneous as possible in order to be supplied into a headbox of a paper machine. In multi-layer web forming, it is also known to use several different stock systems for feeding different fibre suspensions into the headbox. In prior art there are also known a short circulation and a headbox allowing layering of additives, fillers and/or fines. One stock feed arrangement of this kind advantageously applied in the invention is disclosed in *FI patent application 934793*. Fillers, fines and additives can also be supplied only in the headbox itself. One arrangement of this kind is described in *EP patent publication 0 824157*.

Quite recently, a novel type of short circulation arrangement has been developed, marketed by the applicant under the trademark **OptiFeed™**, which is described, among other things, in the magazine article *Ein Neuer Ansatz für das Management der Nasspartie, Wochenblatt für Papierfabrikation, vol. 19, No. 20, October 1998*. By using the OptiFeed™ arrangement, the stock volumes of the short circulation are minimized, which enables, among other things, a quick grade change.

The headbox spreads the formed pulp suspension evenly onto a wire section, in which dewatering and couching of the web begin. In prior art there are known several different types of wire sections, or formers, known in themselves to a person skilled in the art; fourdrinier formers, hybrid formers, and gap formers. In recent years, in the manufacture of fine paper, a gap former has become common in which a slice jet produced by a headbox is fed between two wires and the bulk of the water is removed between said wires in two directions. One advantageous gap former arrangement has been described in the paper read by *L. Verkasalo: Efficient Forming at High Speeds, XI Valmet Paper Technology Days 1998*. In the arrangements known in prior art, the fibre and filler distribution in the thickness direction of the web can be controlled to a limited degree, for example, by means of placement and vacuums of the dewatering elements of the former. The fillers often accumulate on the surfaces of the web in dewatering stages.

In prior art there are also known multi-layer headboxes, one of them having been described, for example, in the paper read by *M. Odell: Multilayering, Method or Madness?*, XI Valmet Paper Technology Days 1998 and in FI patent 92 729, and one of them having also been described in the paper read by *P. Ahonen: Challenges for*
5 *Digital Printing Paper*, XI Valmet Paper Technology Days 1998. Multi-layer headboxes allow desired layer structures to be produced in the web by feeding stock in layers between wires.

The web is passed from the wire section to a press section where water is removed
10 from the web by pressing it against one or two felts. A skilled person knows several different press arrangements from prior art, for example, a press based on roll nips, marketed by the applicant under the trademark **SymPress II™**. Recently, instead of roll nips, in the case of all paper and board grades ever-increasing use has been made of an extended nip known in itself in prior art because of its higher dewatering
15 capacity and/or its ability to retain the bulk of the web.

The dryer section in fine paper machines known in prior art has most commonly been formed of a dryer section which uses conventional single- and/or twin-wire draw and in which drying takes place mainly as cylinder drying while the wire
20 presses the web against a heated cylinder surface. At high running speeds, single-wire draw through the entire dryer section has become common in recent years. As the most recent arrangement, for example, the patent application *PCT/FI98/00945* has proposed combining impingement drying with cylinder drying in order to provide a higher evaporation rate and a shorter dryer section.

25

In several fine paper machines known in prior art, the paper web is passed from the dryer section to a precalender, which in known arrangements may be a calender with hard or soft nips, in which the paper web is passed through the nip between rolls to provide smoothness to the surface of the paper web. Recently, also in the case of
30 fine paper, a so-called soft calender has become common which comprises a soft coated roll and a hot hard-faced thermo roll. In the precalender, loose fibres and other stock components are also fixed to the surface of the web, but, at the same

time, differences in density may also be caused in the base paper and some of the bulkiness of the web important to many grades may be lost.

After that, in the fine paper machines known in prior art there is precoating, for example, a surface sizing or pigmenting unit. In surface sizing, the surfaces of the web are treated with a starch or pigment solution in a film size press, for example, by means of an applicator device marketed by the applicant under the trademark **SymSizer™**. Surface sizing, pigmenting, or coating is performed at this stage typically on both sides of the web at the same time, but the surfaces of the web can also be treated separately in successive units. After that, the paper web is dried by using infrared dryers and airborne web-dryers as well as a subsequent cylinder group or groups, and the paper web is reeled by means of a machine reel-up.

After that, in the manufacturing process of fine paper according to prior art there is an unwind stand, from which the web is passed to an off-machine coating station. Different coating devices are known in prior art, such as, for example, coating devices of the blade coating, jet, film transfer or spray type. A coating agent is transferred by means of the coating device freely to the surface of the web either as a continuous jet (jet) or as drops (spray) or the coating agent is applied by a roll. In one known arrangement, one side of the paper web is precoated first, after which there is a dryer section, and after that the other side of the paper web is precoated, which is followed by a dryer section. The coating of the thus produced precoated web is completed by coating it with other coating layers and, after that, the web is dried, and wound up. The dryer part of the coating station typically comprises first a unit which is not in contact with the web, for example, an infrared dryer, and a cylinder group located after that. In the end, the web is unwound and calendered by means of a supercalender, which imparts a desired level of smoothness and gloss to the web. Reeling ends the fine paper machine line. One reel-up known in prior art is the reel-up marketed by the applicant under the trademark **OptiReel™**.

With respect to the prior art related to the invention, reference is also made to the applicant's *FI patent applications 981330 and 981331*. In these, FI patent application

981330 discloses an integrated paper machine by which paper of good quality can be manufactured with high efficiency at a speed exceeding 2000 m/min, and which is shorter than present paper machines.

- 5 FI patent application 981331 discloses a paper machine which is intended in particular for the manufacture of paper which has copy paper properties as well as high gloss and suitable porosity for colour powder printing.

10 One problem in the fine paper machines known in prior art is particularly their space requirement because of the long machine, and the fact that the change of grade takes a long time. For example, when a conventional short circulation is used, the change of grade takes about two hours. Moreover, when cylinder drying is used, because of the high heat capacity of the cylinders, the changing of heating power is a slow process.

15

An object of the invention is to provide a method and a paper machine for fine paper, in particular for CWF fine paper, i.e. coated woodfree (Coated Wood Free) fine paper, in which operations take place on-line. The invention is also suitable for use in the manufacture of uncoated woodfree fine paper (UCWF, UnCoated Wood

20 Free).

25

An object of the invention is to provide a method and a paper machine for the manufacture of fine paper in which the change of grade is fast. The fast change of grade allows short delivery times so that different paper grades can be delivered to customers just at the right time.

Furthermore, an object of the invention is to provide a method and a paper machine for the manufacture of fine paper allowing different profile control arrangements.

- 30 In connection with the invention, it shall be particularly noted that several of the techniques used in the method and in the paper machine in accordance with the invention have become known separately only quite recently in connection with

different paper or board grades. In this invention, the inventor has realized the possibility of assembling from the new technologies a fine paper machine line which produces high-quality fine paper with good efficiency.

- 5 With a view to achieving the objectives stated above as well as those which will come out later, the method according to the invention is mainly characterized in what is set forth in the characterizing part of claim 1.

The paper machine line according to the invention is in turn mainly characterized in
10 what is set forth in the characterizing part of claim 18.

In accordance with the invention, the fine paper manufacturing line is constructed in an integrated manner. The invention uses most advantageously a short circulation arrangement marketed by the applicant under the trademark **OptiFeed™** or a similar
15 type of short circulation arrangement, one of them being described in *FI patent application No. 981327*, in which the dilution of component stocks to a metering consistency takes place before the stock chests of the component stocks, the regulation of the basis weight takes place from the stock chests of the component stocks by means of regulation of the flows of the component stocks, and the dilution to the
20 headbox consistency takes place in two stages, of which the first one has an invariable flow, and in the second stage the flow is regulated by means of a control signal received from the headbox pressure regulation. This kind of short circulation, in which the volume of the short circulation has been minimized, enables a fast grade change because it uses little stock and extra mixing stages have been omitted from
25 it. Moreover, in such a short circulation process an abundance of automation is used, which further contributes to the fact that the change of grade can be shortened from an hour to a few tens of seconds. For example, a 15 % change of the basis weight takes a few tens of minutes when applying a conventional short circulation, while it is shortened to a few tens of seconds when using an arrangement of the **OptiFeed™**
30 type.

As the headbox the invention uses the headbox marketed by the applicant under the trademark **OptiFlo™** or a similar type of headbox, in which the basis weight profile can be controlled by consistency adjustment and the fibre orientation can be affected by adjusting the profile. In the headbox, it is possible to use layering, layering of
5 additives or fillers, in respect of which reference may be made, for example, to the applicant's *EP patent 651 092*.

As the former is used a gap former which allows higher speeds than other types of formers and carries out dewatering on two sides, whereby symmetric paper is
10 obtained. As one gap former of this kind may be mentioned, for example, the wire section marketed by the applicant under the trademark **OptiFormer™** or a similar type of former, one of them having been described, among other things, in the paper read by *L. Verkasalo: Efficient Forming at High Speeds, XI Valmet Paper Technology Days 1998*.

15 The fine paper manufacturing line according to the invention makes use of extended nip pressing. A so-called shoe press provides good bulk and high dry solids and the lowest possible asymmetry in the web. When using, for example, the applicant's double-felted **OptiPress™** press section, symmetric dewatering and a web having
20 symmetric surface properties are achieved. When it is desirable to achieve high dry solids, it may be beneficial to replace one felt with a non-water-receiving fabric which transfers the web well, with a so-called transfer belt.

In the invention, the dryer section employs both cylinder and impingement drying,
25 one of such dryer sections being described, for example, in the international patent application *PCT/FI98/00945*. Advantageously, for example, a dryer section marketed by the applicant under the trademark **OptiDry™** or a similar type of dryer section is used. In such a dryer section where impingement drying is used in addition to cylinder drying, the change of grade is quick because it takes considerably less time
30 to change impingement drying parameters than to change the temperature of massive drying cylinders. Impingement drying also allows more efficient control of the moisture profile than conventional cylinder drying alone.

When desired, precalendering can be used in the dryer section, such precalendering being described, for example, in *FI patent application 960925*, which discloses calendering against a drying cylinder. Precalendering can also be performed between two rolls. Naturally, when needed, precalendering can also be carried out in a traditional manner after the dryer section. In that connection, the calender is either a hard nip calender or a soft calender. An extended nip calender can also be utilized advantageously in the arrangement according to the invention. Irrespective of where the precalender is located, relatively low loads, for example, below 80 kN/m are used in calendering in accordance with the invention. By this means, one important property of fine paper, bulk, can be conserved. On the other hand, the wet end of the fine paper machine according to the invention, which makes symmetric paper, allows low linear loads in the calender.

In the fine paper machine line in accordance with the invention, precalendering is followed by precoating. The function of precoating is to make the pores present in the surface structure of the base paper smaller in a suitable manner in order that the surface coating proper shall remain on the surface and shall not be absorbed into the structure of paper. In the precalendering, a surface sizing / pigmenting unit marketed by the applicant under the trademark **SymSizer™** or **OptiSizer™** or a similar type of unit is used which allows profile control of the amount of surface size / pigment.

The precoating is followed by a dryer section mainly applying contact-free drying, which allows a fast grade change. The contact-free drying is followed by a short cylinder group which in itself serves to affect primarily the stabilization of the travel of the web, the draw and tension of the web while the drying process is continued at the same time. The cylinder group may comprise single-wire or twin-wire draw, however, most advantageously single-wire draw. In connection with the contact-free drying, it is possible to use a drying arrangement marketed by the applicant under the trademark **TurnDry™** or a similar type of drying in which the paper web is dried and turned by means of the same device, for example, by means of a combination of a turning device and an airborne web-dryer. This enables a fast grade change and, at the same time, assures stable running of the web.

A suitable coating station, for example, a blade coater, a coating device of the jet or spray type is used in the coating process. In the invention, a coating agent is transferred freely by means of the coating device to the surface of the web either as a continuous jet (jet) or as drops (spray). Advantageously, a coating device marketed
5 by the applicant under the trademark **OptiCoat Jet™** or a corresponding type of coating device is used.

In order to eliminate web breaks, the web may be coated while supported by a belt. Supported coating is described, for example, in the applicant's Finnish patent *FI*
10 *101489* as well as in the article *1998 Coating/Paper Machine Makers Conference, TAPPI Proceedings*.

The drying after coating is started as contact-free drying, for example, by means of a dryer marketed by the applicant under the trademark **PowerDry™** or by means of
15 an equivalent type of dryer, which provides a high drying capacity and, when needed, a quick change of drying capacity. In actual fact, contact-free drying is often the principal form of drying so that the short cylinder group following after it functions mainly as a drive group. The drying stages after surface sizing and/or coating are advantageously provided with a profile control device, whereby the
20 profile control of the drying of the paper web in after-drying stages is possible. Some drying section of the fine paper machine line in accordance with the invention can also be provided, for example, with steam-treatment or moistening devices known in prior art with a view to controlling and adjusting the curl of the paper web.

25 After that, there is an on-line multi-nip calender, for example, a calender marketed by the applicant under the trademark **OptiLoad™** or a corresponding type of calender, which differs from conventional supercalenders in that its linear loads in each nip can be regulated separately. By this means, it is possible to conserve bulk,
30 yet attaining good gloss and smoothness. With respect to this type of calender, reference is made to *FI patent 96334*.

The fine paper machine line according to the invention ends in a reel-up. It is most preferably a reel-up marketed by the applicant under the trademark **OptiReel™** or the type of reel-up which produces low amounts of bottom broke and provides a roll of a high standard to ensure its problem-free further processing.

5

Suitable automatic and measuring devices are incorporated into the method and the paper machine for manufacturing fine paper in accordance with the invention, for example, for the purpose of determining and correcting longitudinal and cross direction profiles of the web or for the purpose of performing a fast grade change.

10 As a measuring device is used, for example, a transverse beam which comprises several sensors or scanners and, at the same time, it is possible to measure machine direction variation, for example, by means of scanning devices.

By way of summary it may be stated that the invention has succeeded in combining
15 in the same concept those essential factors of the fine paper manufacturing line by means of which a high paper quality and a fast grade change can be achieved. These factors include in particular the use of a short circulation which enables a fast grade change and the use of a gap former as a former which allows higher speeds than other types of formers and makes it possible to perform dewatering on two sides,
20 whereby symmetric paper is obtained. Moreover, the double-felted shoe press advantageously used in the invention provides good bulk and high dry solids as well as the lowest possible asymmetry in the web. In the dryer section, at least part of the dryer section is formed of impingement drying, which enables a fast grade change. The calender uses low nip loads and both surfaces are treated at the same time in the
25 surface sizing / pigmenting stage. Cylinder drying and non-web-contacting drying are combined in an after-dryer section, which contributes to enabling a fast grade change. Paper is treated on both sides in surface treatment units, which is followed by a dryer section comprising mainly contact-free drying. The calender is an on-line multi-nip calender in which the linear loads in each nip can be regulated separately.
30 By this means, a desired gloss and smoothness level is achieved while still retaining bulk.

In the invention, the possibility of profile control is ensured by the fact that profiling devices are used as devices. The basis weight can be profiled by adjusting the consistency in the headbox. In the press section, a steam box can be used for increasing and profile control of dry solids. Impingement drying allows profile control of drying. In the dryer section it is also possible to use a moistening device for profile control of dry solids, and in sizer types of coaters surface size / the amount of coating can be profiled. It is easy to combine profile control with non-web-contacting drying and, when needed, before the calender it is possible to use, for example, a moistening device which is based on steam or water mist and by means of which it is possible to control the moisture profile of the web and affect its curl.

In connection with the invention, control of the curl of the paper web can be used, in which respect reference is made to *FI applications 906216, 950434, 964830 and 972080*.

In the following, the invention will be described in more detail with reference to the figure in the accompanying drawing, to the details of which the invention is, however, not by any means intended to be narrowly confined, nor is the invention intended to be limited only to this embodiment which is advantageous in itself.

The figure schematically shows one application of the paper machine in accordance with the invention. It does not show the short circulation or other stock arrangements of the fine paper machine in accordance with the invention. In respect of them, reference is made to the magazine article mentioned previously *Ein Neuer Ansatz für das Management der Nasspartie, Wochenblatt für Papierfabrikation, vol. 19, No. 20, October 1998* and to patent application *FI 981327*.

As shown in the figure, stock is fed from a headbox 100 to a wire section 200, in which there is a gap former 250 which drains water on two sides. In a press section 300, at least one press nip is an extended nip press. In the press of the figure, a first nip 350 is a roll nip and a second nip 360 is an extended nip, advantageously a shoe

press, which conserves bulk and reduces two-sidedness in dewatering of paper. The web W is passed from the press section 300 to a forward dryer section 400, in which single-wire draw groups R and impingement drying 450 are used in the application illustrated in the figure. In the application shown in the figure, the impingement drying units 450 are formed of a large-diameter cylinder 420 placed in a basement space and of an impingement drying apparatus 422 placed in connection therewith. The forward dryer section 400 is followed by a measurement frame 490, among other things, for measuring cross profiles of the web. In the example of the figure, a calender 500 is a soft calender. It is followed by a precoating station 600 based on film transfer applying roll application for surface sizing / pigmenting of the web, and by an after-dryer section 650, which is composed of a section 660 mainly applying contact-free drying (infrared drying, airborne web-drying) and of a short cylinder group 670. After that, the web is coated in coating stations 700,800, in which one side of the web is first coated in the first coating station 700, which side is dried in a dryer unit 750 mainly using contact-free drying 760, after which there is a short cylinder group 770. The other side of the web is coated in the second coating station 800, which is followed by a dryer section 850 which mainly applies contact-free drying 860, after which there is a short cylinder group 870. This is followed by a calender in which the paper web is calendered so as to have desired gloss and smoothness in a multi-nip calender 900, in which the loading pressure in each nip can advantageously be regulated separately. Finally, the web is reeled into rolls by means of a reel-up 1000.

In the paper machine shown in the figure, the travel of the paper web W is as follows. The stock is fed from the headbox 100 into a gap between forming rolls 210, 220 of the gap former 250 of the wire section 200, from which it is passed between wires via the dewatering devices of the gap former 250 further to the press section 300 while supported by a wire. The press section 300 comprises two presses 350 and 360. The web W is passed on an upper fabric of the first press, while supported by a lower fabric, so as to be between the press rolls of the press 350. From the lower fabric, the web W is passed onto an upper fabric of the next press 360 and further between the upper fabric and a lower fabric so as to be between the

press rolls of the press 360. The web W is passed from the press section 300 to the dryer section 400, in which the web W is dried, while supported by drying wires, in the impingement drying groups 450 and in the drying groups R that apply single-wire draw. In the drying groups R applying single-wire draw, the reference numeral 5 415 designates the drying wire and the reference numeral 410 designates heated drying cylinders in an upper row and the reference numeral 411 designates reversing cylinders or rolls in a lower row. The web W runs meandering from the reversing cylinders/rolls 411 of the lower row onto the heated drying cylinders 410 of the upper row, on which the web W is in direct contact with the heated cylinder surface.

10 For the sake of clarity, the above-noted signs have been indicated only in connection with one drying group. After that, the web W is passed via the measurement device 490 to the calender 500. Rolls of the precoating unit 600 are denoted with the reference numerals 645 and 647 and the reference numerals 648 and 649 designate film transfer equipment of the precoating unit. The web W is passed through a first

15 contact-free drying and turning device 660 via a second contact-free drying device, for example, an infrared/airborne web-dryer 660 to the drying group 670 which applies single-wire draw and which comprises a drying wire 651 and heated drying cylinders 610 as well as reversing cylinders/rolls 611. After that, the web is coated in the coating stations 700,800, in which the web is passed from the coating station

20 700;800 into the drying equipment 760;860 applying contact-free drying, said drying equipment being followed by the drying group 770,870 applying single-wire draw and comprising a drying wire 751,851, heated drying cylinders 710,810 and reversing cylinders/rolls 711,811. The precoating section 600 is followed by a measuring device 690 which is placed between the section 660 applying contact-free

25 drying and the cylinder group 670. In addition, a measuring device 790,890 is placed after each coating station 700,800. Furthermore, a measuring device 880 is also placed in connection with the latter coating group before the cylinder group 870. After that, the web W is passed to the on-line multi-nip calender 900. After the calender 900, the web W is passed to the reel-up 1000, in which the paper web W

30 is reeled into paper rolls.

Above, the invention has been described only with reference to one of its advantageous embodiment examples, to the details of which the invention is, however, not intended by any means to be narrowly confined. Many variations and modifications are feasible within the inventive idea defined in the following claims.

Claims

1. A method for the manufacture of paper, in particular of fine paper, in which method paper stock is fed from a headbox (100) to a wire section (200) in which water is drained from a paper web (W), in which method the paper web (W) is passed from the wire section (200) to a press section (300) to press water out of the paper web (W), and in which method, after the press section (300), the paper web (W) is dried in a dryer section (400), precalendered and precoated in a precoater (600), after which the paper web (W) is dried in a drying section (650) and coated in a coating station/stations (700,800), after which the paper web (W) is dried in a drying section/sections (750,850), calendered in a calender (900), and reeled in a reel-up (1000), **characterized** in that in the method
- the stock is fed into the headbox (100) from a short circulation the stock volume of which has been minimized,
 - in the wire section (200), water is drained from the paper web (W) in a former, most advantageously in a gap former (250),
 - in the press section (300), water is pressed out of the paper web (W) in at least one extended nip press (360),
 - in the dryer section (400), at least part of the drying of the paper web (W) is carried out by means of impingement drying (450),
 - the paper web (W) is precalendered in a calender (900) employing low nip loads,
 - both surfaces of the paper web (W) are precoated at the same time,
 - after precoating (500), the paper web (W) is dried by means of contact-free drying (660),
 - the paper web (W) is coated in an on-line coating station/stations (700, 800), after which the paper web (W) is at least partly dried in a drying section/sections (750,850) by means of contact-free drying of the paper web (W), and
 - the paper web (W) is calendered in an on-line calender (900) while the linear load in each nip is regulated separately.

2. A method according to claim 1, **characterized** in that, in the method, the basis weight profile is controlled by consistency adjustment in the headbox (100) in order to affect the fibre orientation of the paper web (W) by controlling the profile.
- 5 3. A method according to claim 1, **characterized** in that, in the method, a shoe press is used as the extended nip press (350,360).
4. A method according to claim 1, **characterized** in that two felts or a felt and a transfer belt are used in the press nips in the press section (300).
- 10 5. A method according to any one of the preceding claims, **characterized** in that, in the method, the amount of surface size / pigment used in precoating (600) is profiled.
- 15 6. A method according to any one of the preceding claims, **characterized** in that, in the method, combinations of impingement drying and cylinder drying or non-web-contacting drying and cylinder drying are applied to the drying of paper in order to accomplish a fast grade change.
- 20 7. A method according to any one of the preceding claims, **characterized** in that, in the method, in connection with the contact-free drying carried out after precoating (600) and coating (700,800), the drying of the paper web is profiled by means of a profiling device.
- 25 8. A method according to any one of the preceding claims, **characterized** in that, in the method, a coating device of the blade, jet or spray type is used in the coating (700,800).
- 30 9. A method according to any one of the preceding claims, **characterized** in that, in the method, the paper web (W) is measured by means of sensors fixed to a transverse beam in order to monitor properties of the paper web (W), and that, in

the method, the profiling of the properties of the paper web (W) is controlled based on the measurement results.

10. A method according to any one of the preceding claims, **characterized** in that,
5 in the method, the drying of the paper web in the dryer section (400) is profiled by using impingement drying.

11. A method according to any one of the preceding claims, **characterized** in that,
in the method, a moistening device based on steam or water mist, placed before the
10 calender (900), is used for profile control of curl.

12. A method according to any one of the preceding claims, **characterized** in that,
in the method, precalendering against a cylinder or a roll is used in the dryer
section.

15 13. A method according to any one of the preceding claims, **characterized** in that,
in the method, the paper web (W) is supported by means of belts in the end part of the paper machine.

20 14. A method according to any one of the preceding claims, **characterized** in that,
in the method, the principal drying in the after-drying units is carried out without contact with the web.

15. A method according to any one of the preceding claims, **characterized** in that,
25 in the method, low linear loads, advantageously below 80 kN/m, are used in the precalender (500).

16. A method according to any one of the preceding claims, **characterized** in that,
in the method, precalendering is carried out using an extended nip calender.

17. A method according to any one of the preceding claims, **characterized** in that, in the method, fine paper is manufactured using layering of fibres and/or additives and/or fillers.

5 18. A paper machine line in particular for the manufacture of fine paper, which line comprises a short circulation, a headbox (100), a wire section (200), a press section (300), a dryer section (400), a precalender (500), a precoater (600) and a drying section (650) after that, a coating station/stations (700, 800) and after-drying section/sections (750,850), a calender (900) and a reel-up (1000), **characterized** in
10 that the paper machine line comprises a short circulation the stock volume of which has been minimized, that the wire section (200) comprises a former (250), that the press section (300) comprises at least one extended nip press (360), that at least part of the dryer section (400) is based on impingement drying (450), that the precoater (600) of the paper web (W) is two-sided, and that the paper machine line further
15 comprises an on-line coating station/stations (700,800) and, placed after said station/stations, a drying section/sections (750,850) substantially based on contact-free drying, and that in the paper machine line there is an on-line calender (900) in which the linear loads in each nip can be regulated separately.

20 19. A paper machine line according to claim 18, **characterized** in that the on-line calender is a multi-nip calender.

20. A paper machine line according to claim 18 or 19, **characterized** in that the headbox (100) is a multi-layer headbox.

25

21. A paper machine line according to claim 18 to 20, **characterized** in that the wire section is a gap former.

22. A paper machine line according to any one of claims 18 to 21, **characterized**
30 in that a latter nip (360) of the press section is an extended nip press.

23. A paper machine line according to any one of claims 18 to 22, **characterized** in that in the press nips of the press section there are two felts or a felt and a transfer belt.

5 24. A paper machine line according to any one of claims 18 to 23, **characterized** in that the coater (700,800) is a coating device of the blade, jet or spray type.

25. A paper machine line according to any one of claims 18 to 24, **characterized** in that its drying sections (400,600,750,850) comprise as a combination both
10 cylinder drying and impingement drying or cylinder drying and non-web-contacting drying.

26. A paper machine line according to any one of claims 18 to 25, **characterized** in that the after-drying sections (600,750,850) have been so dimensioned that
15 principal drying takes place without contact with the web.

27. A paper machine line according to any one of claims 18 to 26, **characterized** in that the paper machine line comprises a moistening device based on steam or water mist, placed before the calender, for profile control of curl.
20

28. A paper machine line according to any one of claims 18 to 27, **characterized** in that the drying section comprises a precalendering device placed against a cylinder or a roll.

25 29. A paper machine line according to any one of claims 18 to 28, **characterized** in that the end part of the paper machine comprises belt support of the paper web.

30. A paper machine line according to any one of claims 18 to 29, **characterized** in that the precalender of the paper machine line is a soft or extended nip calender.

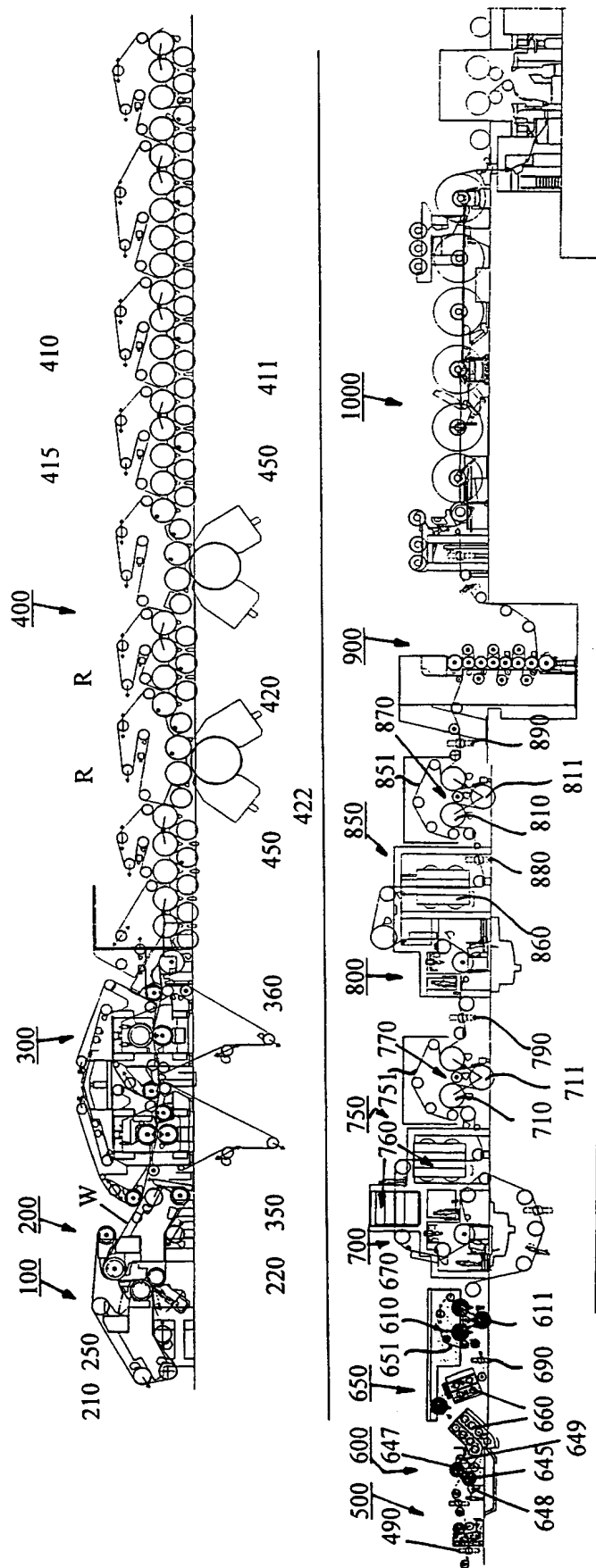


FIG.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00419

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21F 11/00, D21F 9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21F, D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI,PAJ,EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9530049 A1 (VOITH SULZER PAPIERMASCHINEN GMBH), 9 November 1995 (09.11.95), figures 1,5, claims 1, 2, abstract --	1-30
A	EP 0726353 A2 (VALMET CORPORATION), 14 August 1996 (14.08.96), column 5, line 41 - column 6, line 41, figures 1-13, abstract --	1-30
A	US 5087325 A (ROBERT E. PAGE), 11 February 1992 (11.02.92), column 2, line 16 - column 1, line 57, figure 1, claims 1,2, abstract --	1-30

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00419

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0427887 A1 (BELOIT CORPORATION), 22 May 1991 (22.05.91), column 2, line 31 - column 3, line 27, figures 1-3, claims 1,4,11, abstract --	1-30
P,A	WO 9964672 A1 (VALMET CORPORATION), 16 December 1999 (16.12.99), figure 1, claims: 1,3, 5,7-8,11-13,16-17; abstract -- -----	1-30

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/08/00

International application No.
PCT/FI 00/00419

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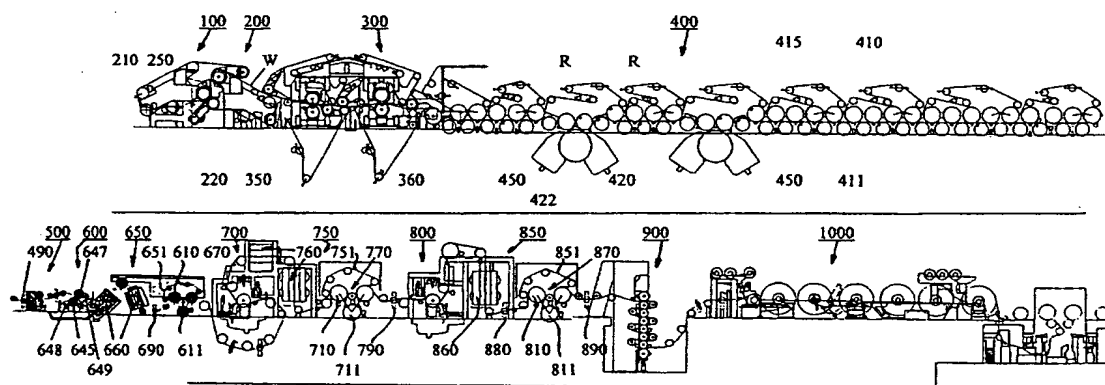
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(57) Abstract

The present invention relates to a method for the manufacture of paper, in particular of fine paper. In the method, paper stock is fed from a headbox (100) to a wire section (200) to drain water from a paper web, the paper web (W) is passed from the wire section (200) to a press section (300) to press water out of the paper web (W), after the press section (300), the paper web (W) is dried in a dryer section (400), precalendered and precoated in a precoater (600), after which the paper web (W) is dried and coated, after which the paper web (W) is dried, calendered and reeled. In accordance with the invention, in the method, the stock is fed into the headbox (100) from a gap former (250), in the press section (300) water is pressed out of the paper web (W) in an extended nip press (360), in the dryer section (400) impingement drying (450) is employed for the drying of the paper web (W), the paper web (W) is precalendered in a calender (900) employing low nip loads, both surfaces of the paper web (W) are precoated at the same time, after precoating (500) the paper web (W) is dried by means of contact-free drying (660), the paper web (W) is coated in an on-line coating station/stations (700, 800), after which the paper web (W) is at least partly dried in a drying section/sections (750, 850) by means of contact-free drying of the paper web (W), and the paper web (W) is calendered in an on-line calender (900) while the linear load in each nip is regulated separately. The invention also relates to a paper machine line in particular for the manufacture of fine paper.

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B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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